

# **NIF PEPC LRU Test Stand– Safety Note Addendum**

*Daniel Mason*

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**U.S. Department of Energy**

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# **MECHANICAL ENGINEERING SAFETY NOTE ADDENDUM**

**to MESN01-028-OA**

## **NIF PEPC LRU Test Stand**

**Daniel Mason**

**5 September 2001**

Prepared by:

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Daniel Mason

Reviewed by:

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J.W. Trent

Approved by:

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Bob Murray

Distribution:

P. Arnold	L-460
C. Robb	L-489
Engineering Records Center	L-118

## **Revision Justification**

It is necessary that the NIF PEPC LRU Test Stand be modified to accommodate a new experiment. This modification will involve boring two 1/2" holes in the Center Loaded Upper Beam of the stand. These holes will allow a small wire to pass through half of the length of one of the long sections of 80/20 part 3030. The holes could adversely effect the load-bearing capabilities of an important structural member of the stand so calculations must be done to assure a minimal risk of part failure.

## **Design Modifications**

A single, 1/2" diameter hole will be drilled in two places along one of the Center Loaded Upper Beams. These holes will only penetrate halfway through the structural member. One hole will be located near the center of the beam (actually about 4" off-center) and the other will be located 6" from the end. In order to estimate their effect on the beam conservatively, the calculation will assume a hole in the middle of the beam's span (point of max. bending moment).

## **Assumptions**

The load of the cell will be modeled as though it is distributed evenly between the two long upper beams. The center loaded upper beam that is to be modified will be modeled as a simply supported beam with a point load in the center of the span (worst case). Because the beam is actually closer to a fixed-support beam, the calculations are conservative by at least a factor of two. This is due to the fact that the bending moment at the center of a simply supported beam ( $M = F \cdot l / 4$ ) is twice that in a beam with fixed supports ( $M = F \cdot l / 8$ ). In addition, the calculations completely ignore the 45° supports on the beam, which also add to its stability.

## **Testing Requirements**

Because the modifications to the Upper Beam could change the load bearing capabilities of the structure, the stand should be load tested to 150% of the 1.8 kip live load, which is 2.70 kips.

## Calculations

$$M := 23.4 \text{ kip}\cdot\text{in}$$

Bending moment in the beam. See the original safety note for this calculation.

$$C := 1.5 \text{ in}$$

$$I := 3.3625 \text{ in}^4$$

Find new I value (I'):

$$I_0 := b \cdot h^3 / 12$$

$$b := 0.5 \text{ in}$$

This is an extremely conservative estimate of width of the removed section based on the attached drawing (Figure 1). The diameter of the hole.

$$h := 0.5 \text{ in}$$

$$I_0 := 0.005208 \text{ in}^4$$

$$I' := I - I_0 = 3.35729 \text{ in}^4$$

The new MOI of the beam.

New Bending Moment:

$$\sigma' := M \cdot c / I'$$

$$\sigma' = 10.455 \text{ ksi}$$

$$F := 900 \text{ lbf}$$

Half of LRU weight

$$A := 3.371 \text{ in}^2$$

Area of original cross-section

$$A_0 := h \cdot b = 0.25 \text{ in}^2$$

Area removed from cross-section

$$A' := A - A_0 = 3.121 \text{ in}^2$$

New Shear:

$$\tau := F / (2 \cdot A')$$

$$\tau = 144.2 \text{ psi}$$

Von Mises Calculation:

$$\sigma_{vm} := (\sigma^2 + 3 \cdot \tau^2)^{1/2}$$

$$\sigma_{vm} = 10.458 \text{ ksi}$$

Factor of Safety:

$$\sigma_y := 35 \text{ ksi}$$

$$FS := \sigma_y / \sigma_{vm}$$

$$FS = 3.347$$

The hole changed the factor of safety by only 1.57%.

Technical drawing of a mechanical part with the following dimensions and features:

- Overall width: 3.00 Typ
- Top left vertical dimension: .750 Typ
- Top right vertical dimension: .810 Typ
- Left side vertical dimension: 1.50 Typ
- Bottom left vertical dimension: .186 Typ
- Bottom center vertical dimension: .320 Typ
- Bottom right vertical dimension: .484 Typ
- Right side vertical dimension: .315 Typ
- Bottom right horizontal dimension: .160 Typ
- Bottom right diagonal dimension: .160 Typ
- Bottom left horizontal dimension: .262 Thru Typ
- Removed Section callout: A dashed rectangular area on the left side is labeled "Removed Section".